Brahms: Human-Centered Modeling and Simulation

Maarten Sierhuis, William J. Clancey, Ron van Hoof

Ames researchers are combining computational simulation with ethnographical field-observation methods and techniques from the social sciences and knowledge engineering in order to better understand and design the necessary collaboration between man and machine. Researchers are developing a multiagent modeling and simulation environment called Brahms, originally an acronym for "Business Redesign Agent-Based Holistic Modeling System," but now used as an internal product name for the modeling language, as well as the set of tools that comprises the product. Brahms facilitates an engineering paradigm shift from current system-centered engineering to a more human-centered engineering approach, in which an understanding of users of technology is at the center.

The Brahms environment consists of numerous software tools including a multiagent programming language for modeling people's behaviors, geographical environment, movements, communication, systems and tools used in activities, as well as system behaviors. Brahms agents can represent people as well as (intelligent) systems. It also includes a simulation engine for executing Brahms models, a modeling environment for developing and debugging models, and a graphical tool for displaying the result of a multiagent simulation (see figure 1).

The research focuses on investigating the work activities and collaboration between participants in the deployment of complex systems on planetary extravehicular activities (EVAs). During the FY99 Haughton-Mars Project field season at Devon Island, in Nunavut, Canada, researchers observed and videotaped scientists in the field deploying a multitude of systems (for example, the Haughton Crater Network, ultraviolet (UV) boxes, ground temperature sensors, ozone measurement equipment). To understand the complex work activities of astronauts and Mission Control, researchers are studying the work practices of deploying the Apollo Lunar Surface Experiments Package (ALSEP) during the Apollo missions. The Brahms tool is being used to model and simulate the work activities of the Apollo astronauts on the Moon, as well as the communication between the astronauts and mission control on Earth.

A simulation model of the Apollo 12 ALSEP offload activity was created to test the Brahms language capabilities for modeling the work practices of a complex deployment activity during a planetary EVA. To develop the Apollo 12 ALSEP offload model, researchers used historical Apollo archives of

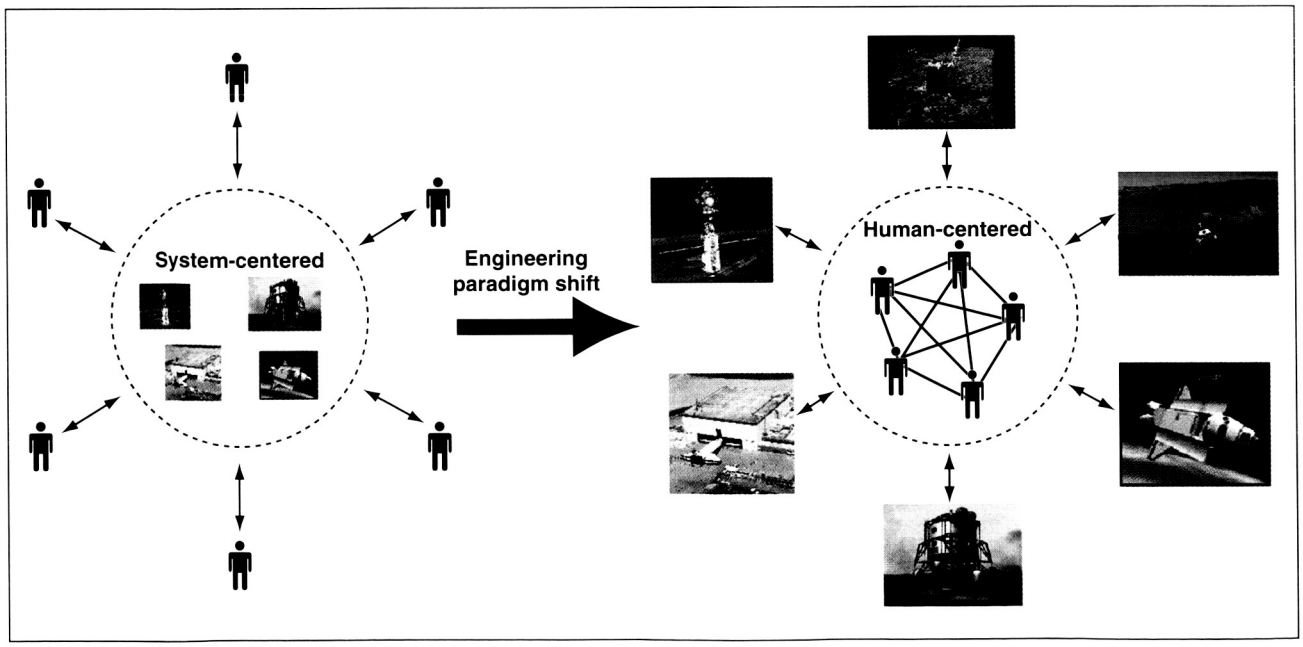

Fig. 1. Brahms environment.

astronaut communications, lunar surface procedures, videos, and photographs. From this historical data the multiagent and object behavior models and the geographical model were designed. To understand the impact of time delays between Mission Control and the astronauts on the Moon, a reusable voice-loop library model was developed to simulate the 1.25 second one-way delay. Using this voice-loop model, the Brahms simulation includes a simulation of communication between Apollo lunar surface astronauts and capsule communicator (CAPCOM). Figure 2 is the Brahms graphical display tool showing the agents' hierarchical subsumed activities over time.

The Apollo 12 Brahms simulation allowed for detailed qualitative and quantitative work system analysis of the collaborative activities, communication, use of space, tools, and systems during the ALSEP offload. The result of the experiment proves that the Brahms multiagent programming language is powerful enough to represent the activities, collaboration, and communication of people and systems, as well as the influence of the geographical context on their behavior.

Point of Contact: M. Sierhuis
(650) 604-4917
msierhuis@mail.arc.nasa.gov

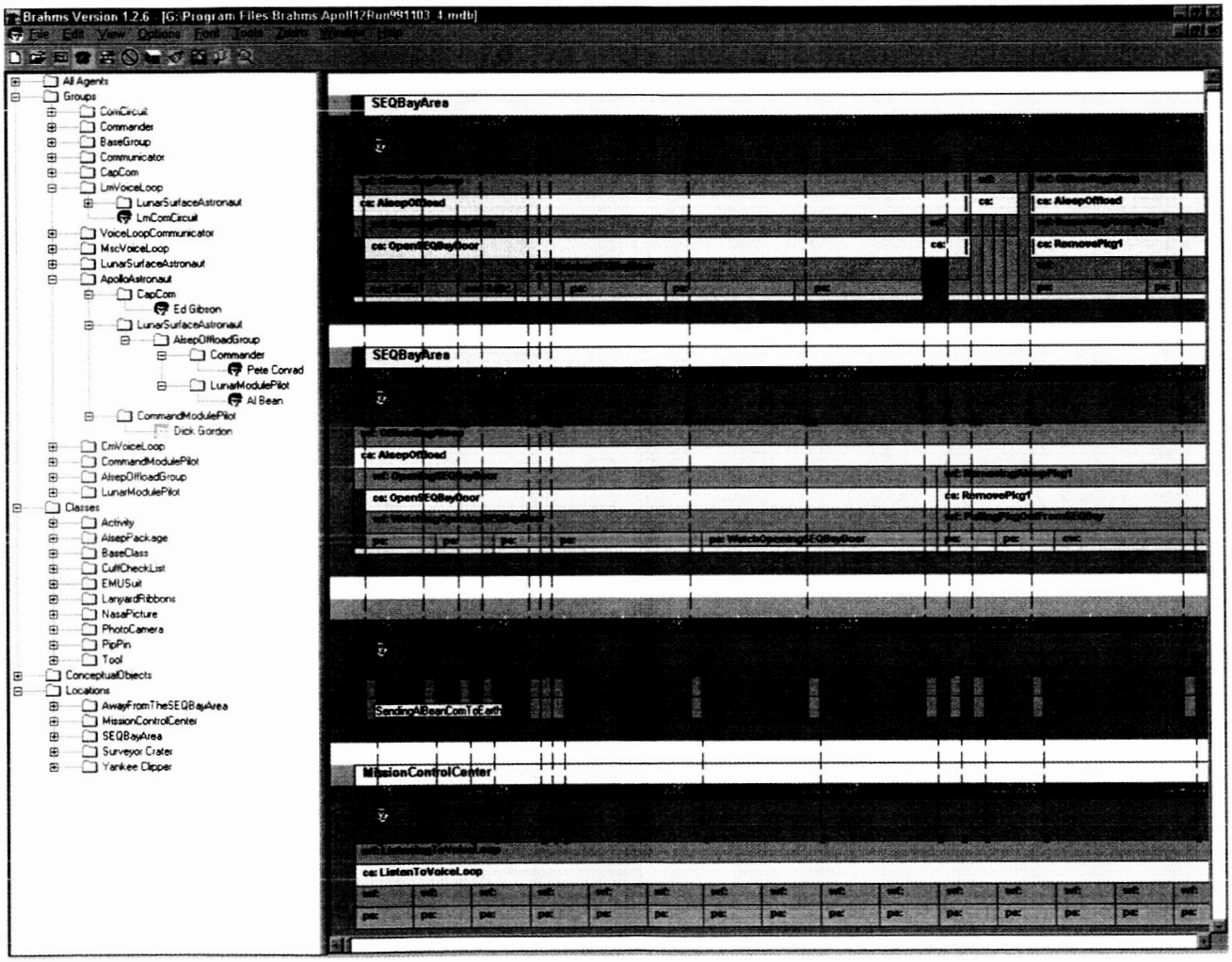

Fig. 2. Brahms graphical display tool.